# The GRID as a Platform for Communication, Collaboration and E-Science

Lawrence Wilcock and Steve Hinde
Hewlett Packard Laboratories, Bristol, UK
lw@hplb.hpl.hp.com

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# Outline

- Important trends in communications
  - Technical & social
- Next generation communication applications
  - Characteristics and requirements
- Grid-based Collaboration Platform
  - Vision, approach, and assumptions
- Requirements for Communication Spaces
  - Control & management of virtual meeting places
- Media Grid
  - Global, media-processing fabric for real-time interactive communications

# Communications in E-science

- Almost everything we do involves communication with others
- Increasing trend towards collaborative research
  - Large multi-disciplinary teams
  - Span organisational and geographic boundaries
  - Faster results, more ambitious goals
- Examples
  - Virtual collaboratories
  - Online Conferences
  - E-learning and Science Lectures
- Where appropriate leverage existing technologies & commercial infrastructure
- Culture of innovation & experimentation
  - Create new technologies and paradigms when needed
  - Web, very high-speed Internet networks, GRID
  - Results feedback into Industry

# Important trends in communication

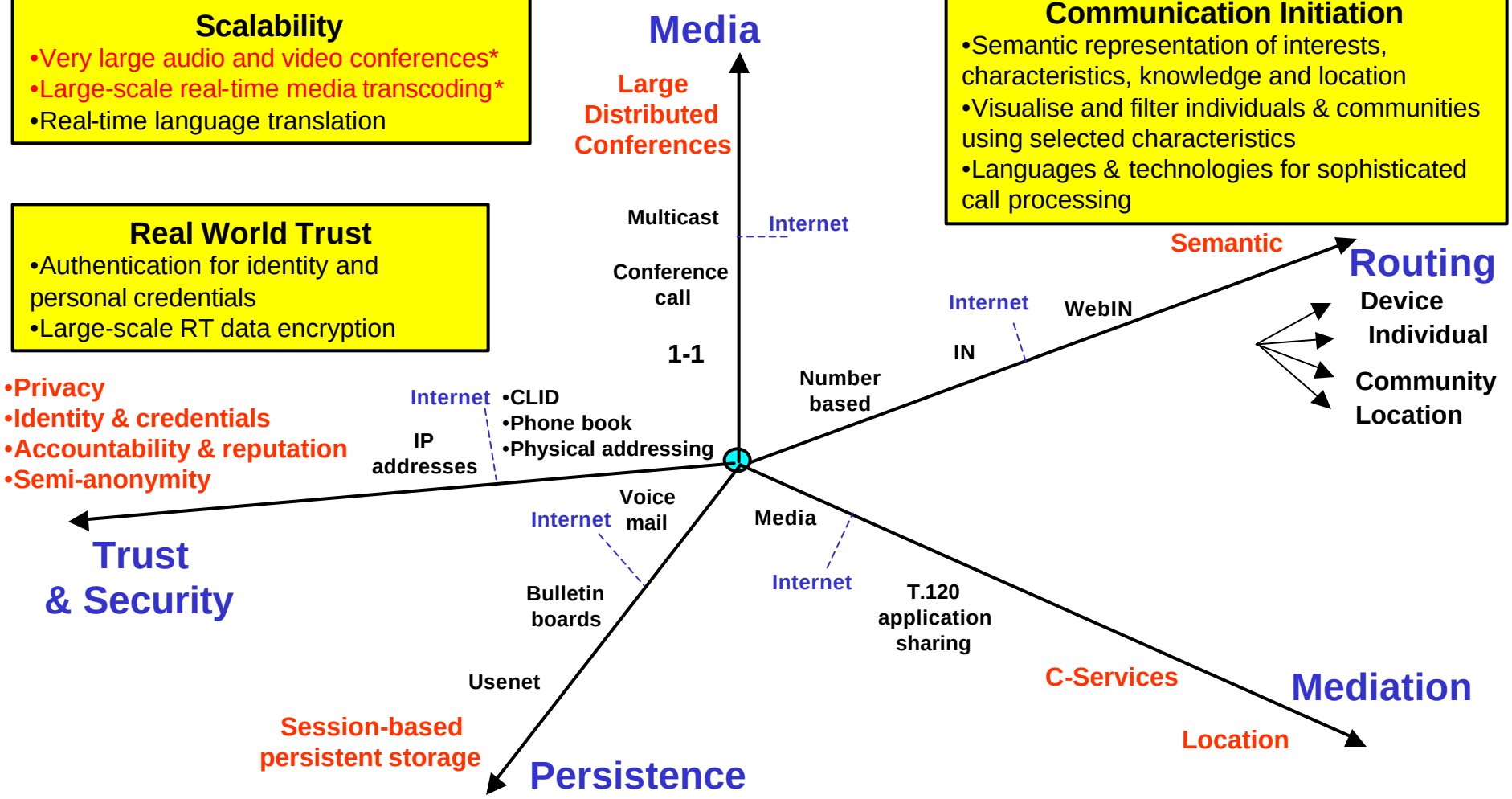
- Technological
  - Greater use of computation and storage in the Network to facilitate communication
  - Exponential increase in bandwidth
    - Richer media types => greater demand for computation
  - Heterogeneity of communication devices
    - Telephone, PDA, games console, DSL-connected PC, powerful workstation on multi-megabit Internet 2
    - Lowest common denominator everywhere not acceptable
- Social
  - Increased use of Internet to communicate and collaborate in groups, teams and online communities
  - People meet in much larger groups
  - Create demand for large-scale deployment of multi-party communication applications
    - Reproduce real-world interactivity and productivity
    - Requires new paradigms and supporting technologies

# Computationally Enhanced Communications

**Scalability**
- Very large audio and video conferences*
- Large-scale real-time media transcoding*
- Real-time language translation

**Real World Trust**
- Authentication for identity and personal credentials
- Large-scale RT data encryption

**Communication Initiation**
- Semantic representation of interests, characteristics, knowledge and location
- Visualise and filter individuals & communities using selected characteristics
- Languages & technologies for sophisticated call processing




**Storage for Communication**
- Persistent meeting places
- Communication memory – network-based, secure, shared storage of communication history and content

**Communication Applications**
- Shared, downloadable, secure communication tools (c-services)
- Augment physical places with communication capability

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# Computation Resource Crisis

- Even simple operations aggregate to huge computation demand
  - billions of users
- Particularly for real-time media
- Telephone network has insufficient compute capacity for audio mixing
  - Provisioned on assumption of 2-party calls
  - Cannot support vision of “Every call is a conference call”
- Problem:
  - Where will the compute and storage resources come from?
  - How will they be managed?
- Answer: the GRID
  - Central Office of the Future
  - Important to understand requirements for the GRID
    - Real-time media, 24x7 availability, security, QoS

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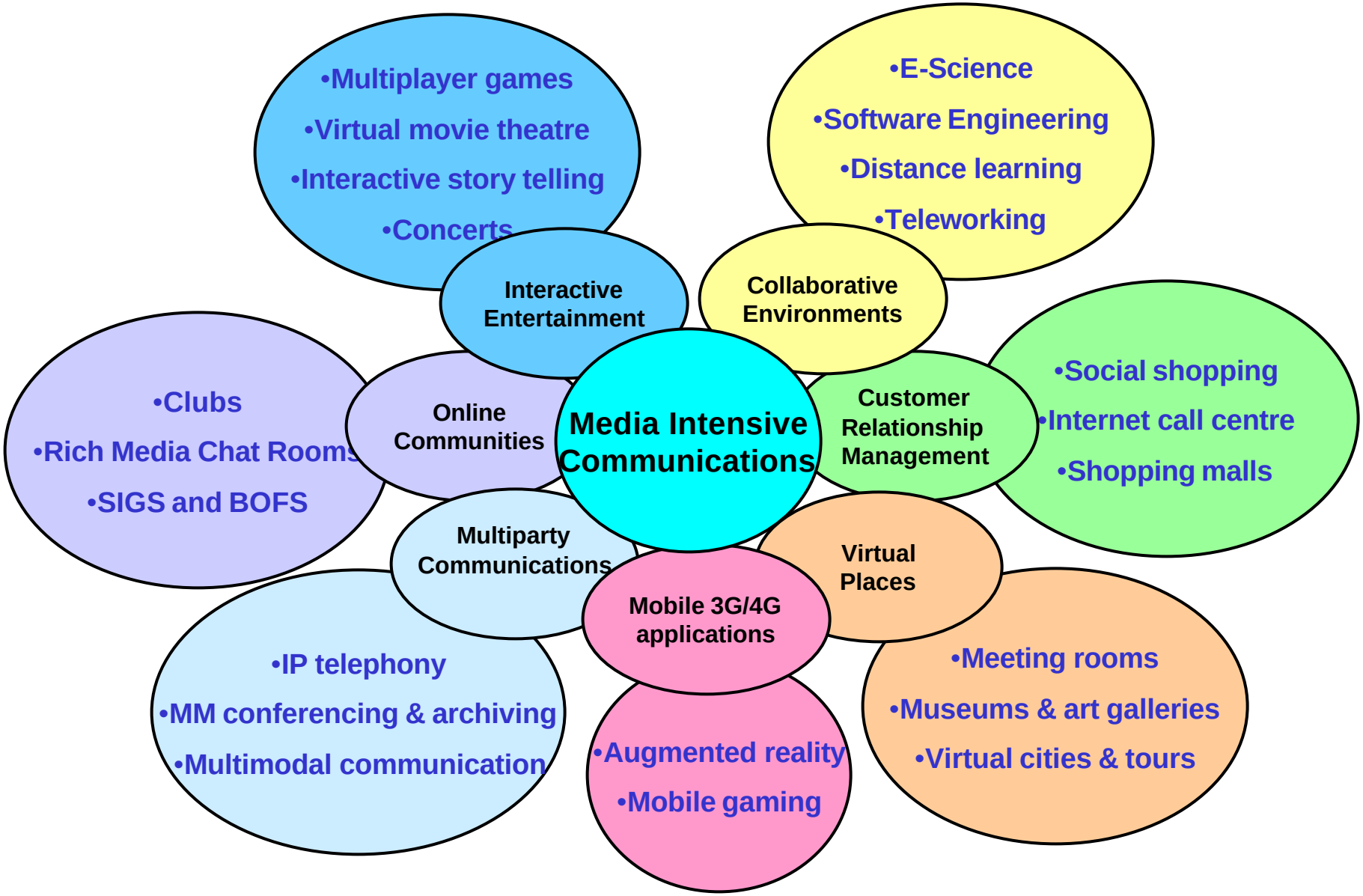
# Large-scale Multi-Party Communications

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# Characteristics of Next Generation Communications Apps

- Structure similar to real world
  - modelled as virtual meeting places
  - Environment: region, building, room, zone, group
  - have physical properties - spatial extent, acoustics
  - notion of position is important
  - Leads to usability scalability for large numbers of participants
    - Multiple simultaneous speakers
    - People can move around to naturally form groups
- Persistent
  - meeting places exist independently of participants
- Huge range in scale
  - From 2 people (& an automated agent)
  - …. to thousands in online game or conference

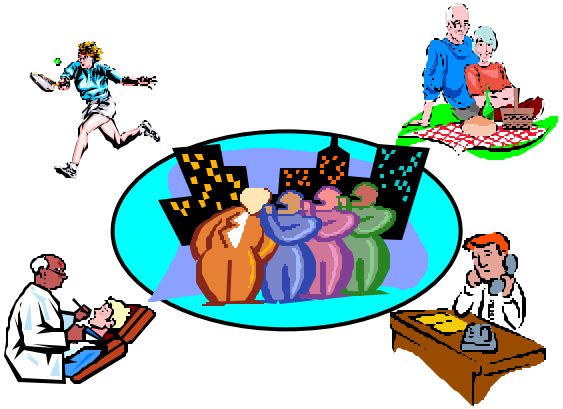
# The Net as a Place

**The Net as a Page**

***Information Delivery***

- Single-user browsing
- Magazine pages
- Information searching
- 1-1 Streamed media

**The Net as a Place**



- Communication
- Interaction
- Real-time social media
- Online communities
- Interest groups
- Collaborative science

***Communication GRID***

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# Implications for Media Processing

- Huge demand of computation, storage, and bandwidth
  - Mixing, transcoding, transcription, voice obfustication, TTS, ASR, media streaming & recording
- Rich media pushing computational demands even further
  - Spatial audio, real-time 3D video avatars
  - Unique mix required for each participant
  - mix contains members of own group & connected groups
- Heterogeneity => Network adaptation for diverse edge devices
  - Adapt to processing and bandwidth capabilities
  - Trade off computation for bandwidth
- Scalability
  - billions of small conferences, and massive online environments

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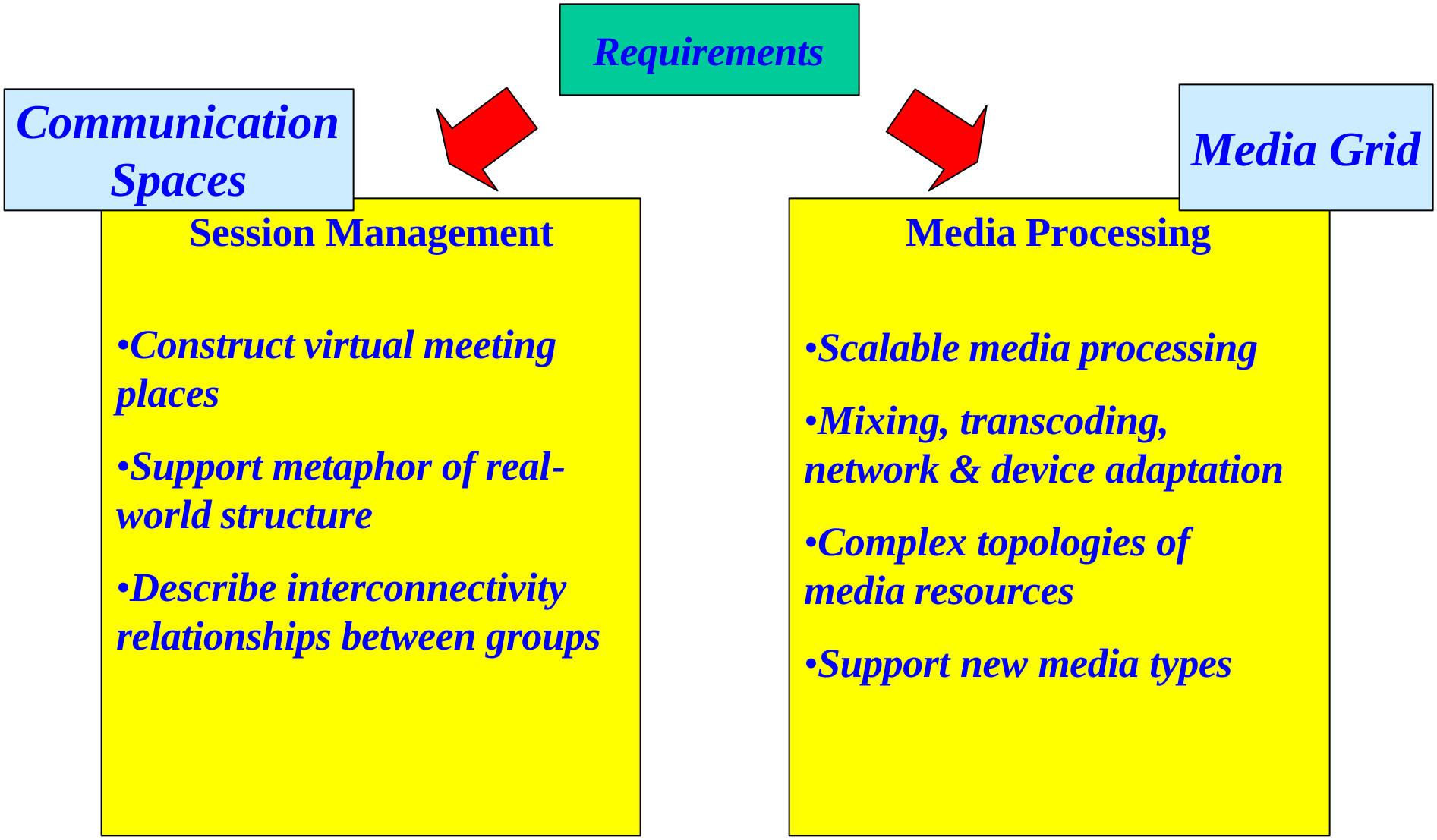
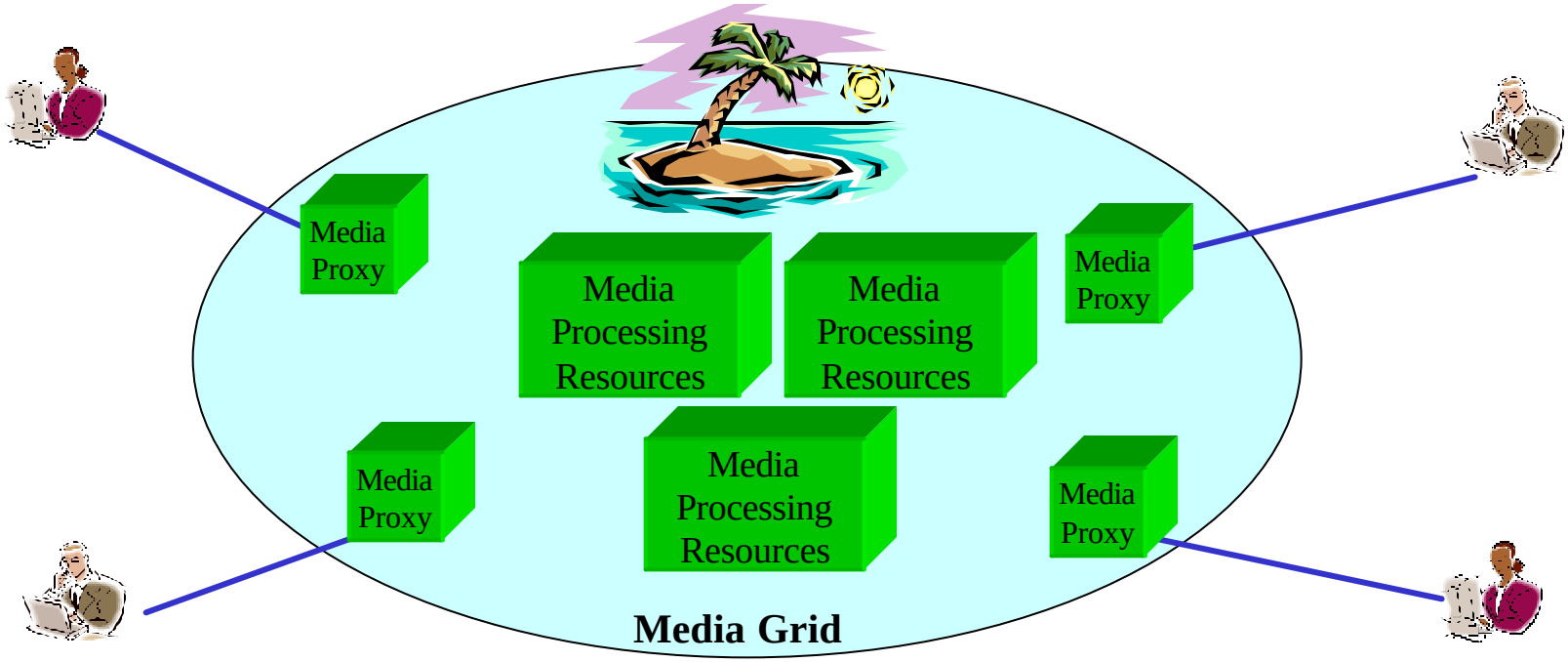
# Implications for the Infrastructure



# Vision

***Enable next-generation communications applications by creation of scalable, planetary-scale Media Grid and Control architecture, composed of mesh of network-resident media-processing resources, allocated from a global pool, And managed using GRID technologies***

# Media Grid for Communications




- Global, distributed pool of media processing resources
- Connected by dedicated well-provisioned IP network
- Media resources are composable into complex meshes
- Media Proxy is user “on ramp” to Media Grid
  - mixing, transcoding, and device adaptation
- Media Resources built on GRID technologies
  - Resource description and allocation, resource virtualisation, service interfaces, security

# Why Network-Hosted Media Processing?

- Edge solutions do not scale well
  - Not all end devices have required processing and bandwidth capability
  - Adapt in network – stream merging, compression, divide and conquer
- Multicast & real-time capable networks are not ubiquitous
  - do not reach all endpoints
- However, can control real-time properties within the Network
- Allows statistical sharing of expensive specialised resources
- Facilitates seamless device mobility

# Assumptions

- Scalability limited by demand for media processing and bandwidth
- Real-time processing and storage of media can now be performed on a large scale in software on general purpose computing platforms
  - HP OpenCall Media Platform – 2000 IVR channels on UNIX SMP

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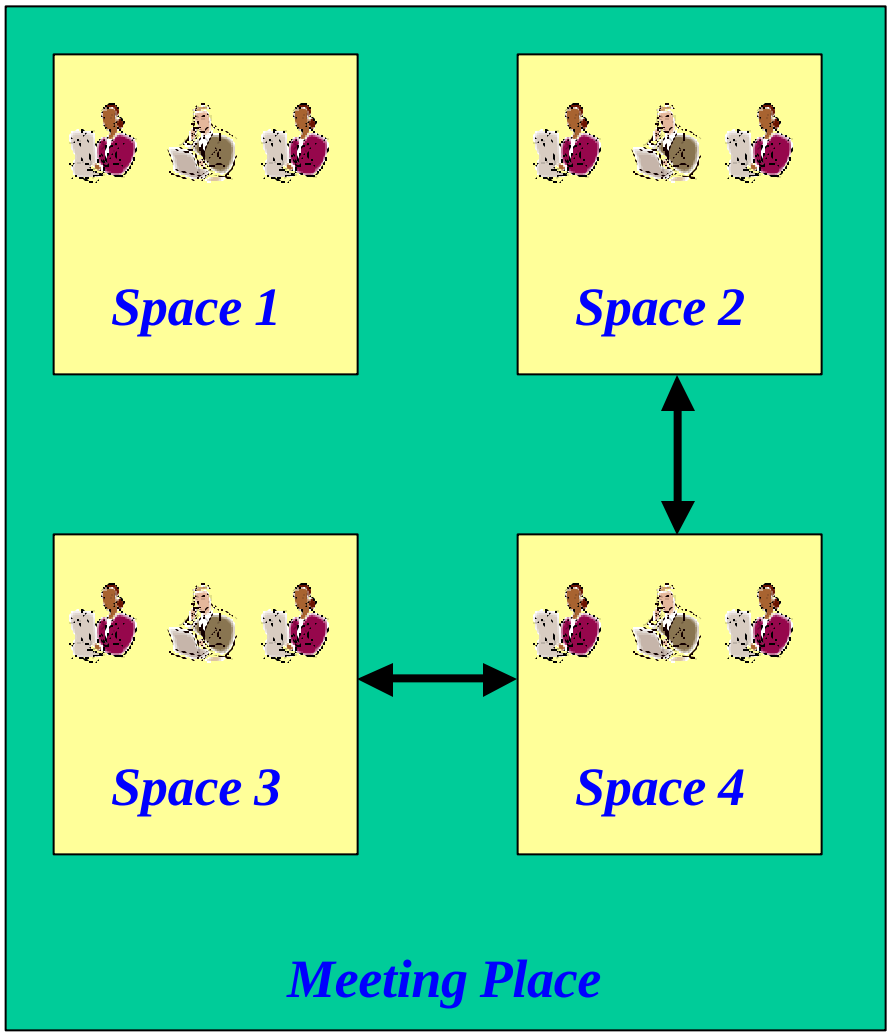
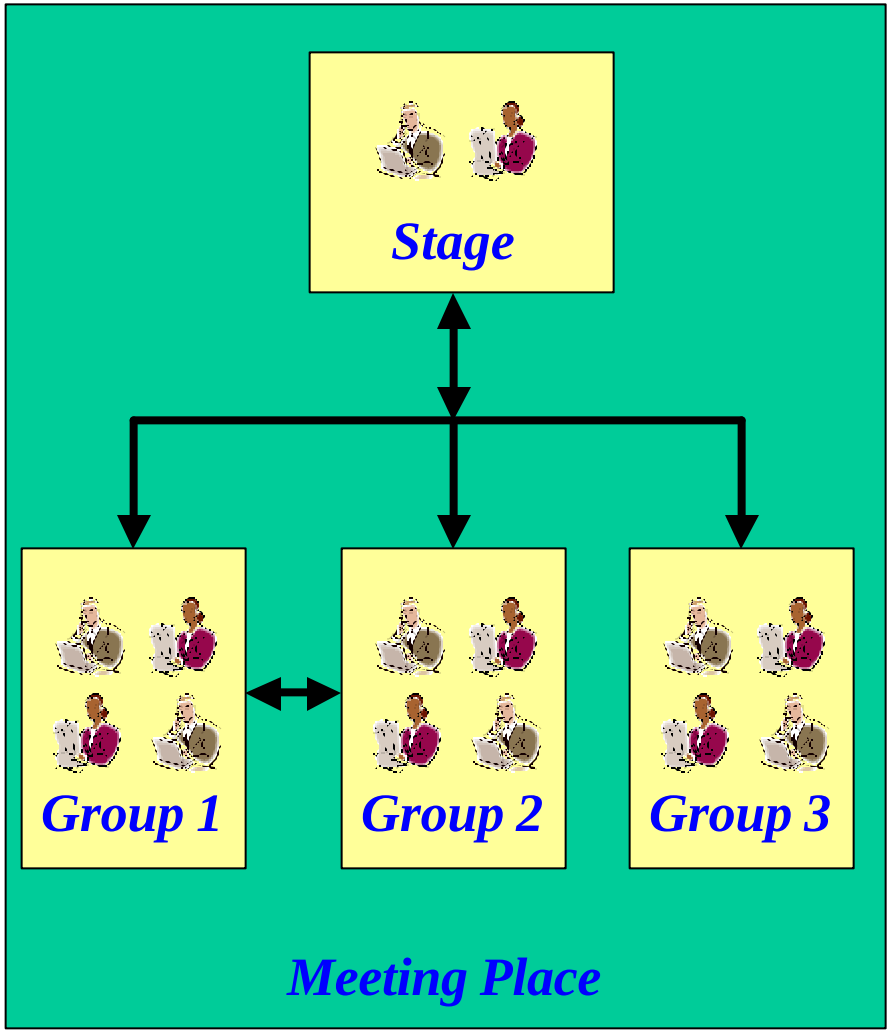
# Spaces - simple meeting place



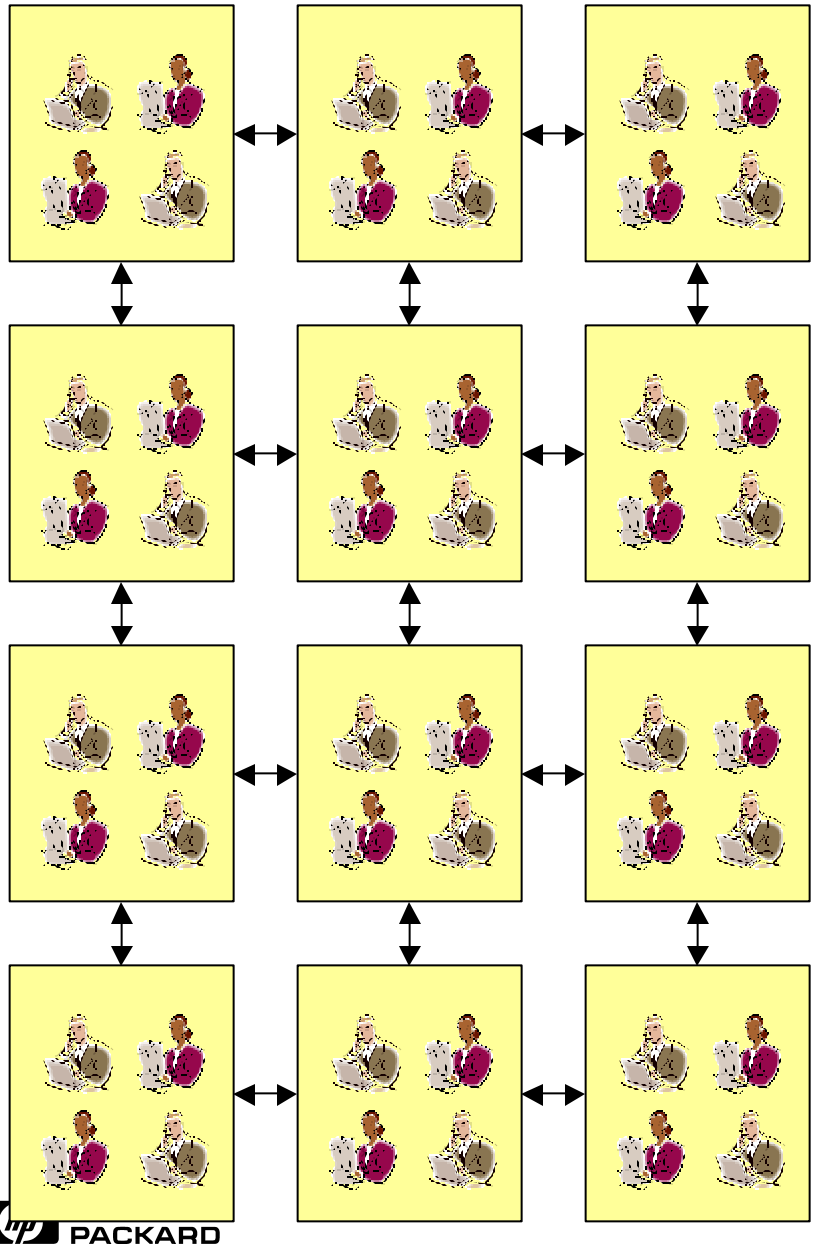

- Similar concerns to a Session
  - Participants communicate in a Space
  - Spaces control membership
  - Invitation & join mechanism
- Extend with VE concepts
  - Environment tiled with Spaces
  - Can have spatial extent
  - Can be connected together
  - Define audio physics
    - Acoustics, reverberation, echo

# Spaces – company broadcast or conference



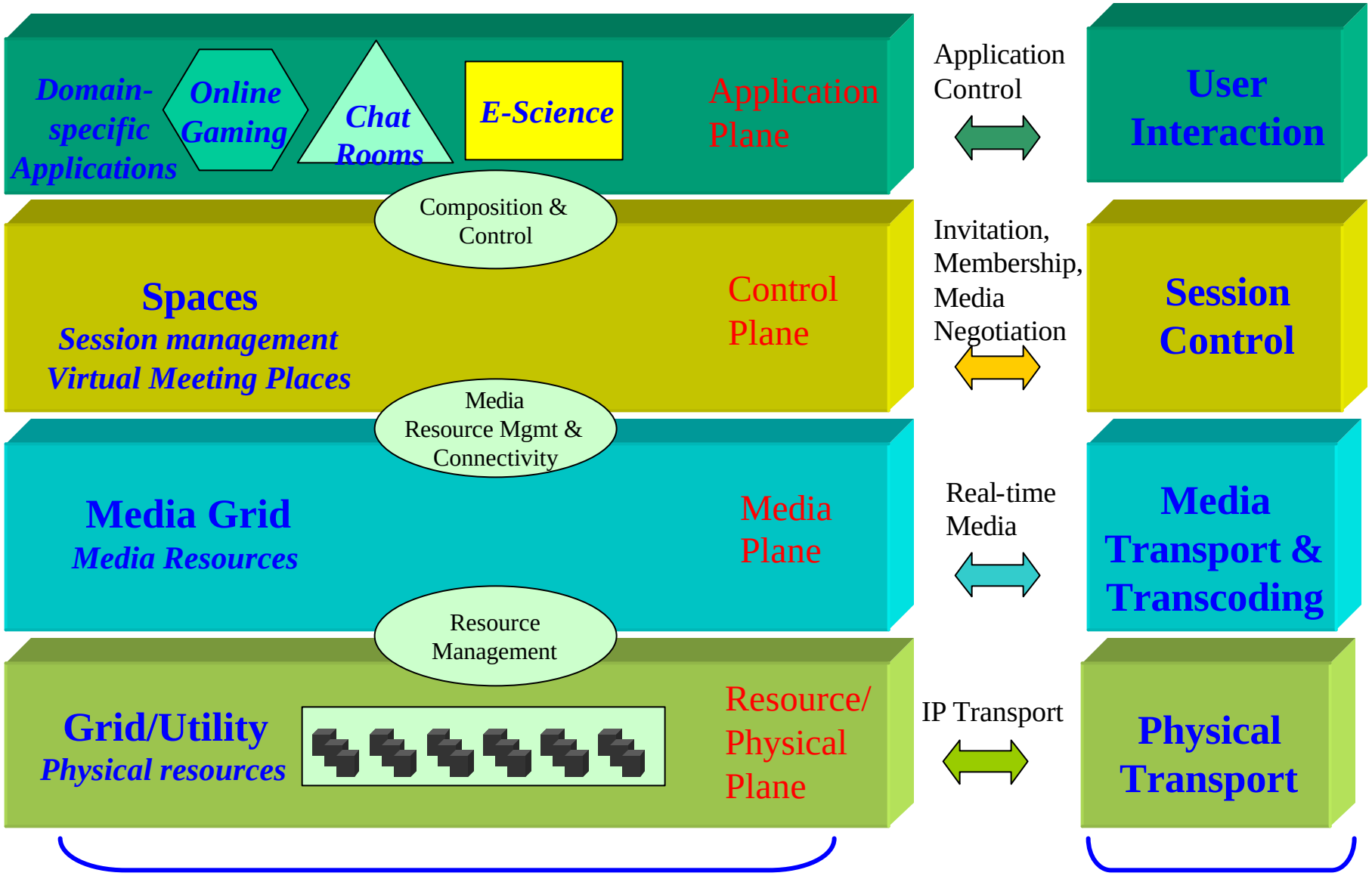

- Create complex media relationships between groups
  - Control flow of media
  - Some listening, some speaking
  - Private conversations

# Spaces – pushing scalability



- Millions of Spaces, billions of users
- Massive online environments
- Surfable Web of places

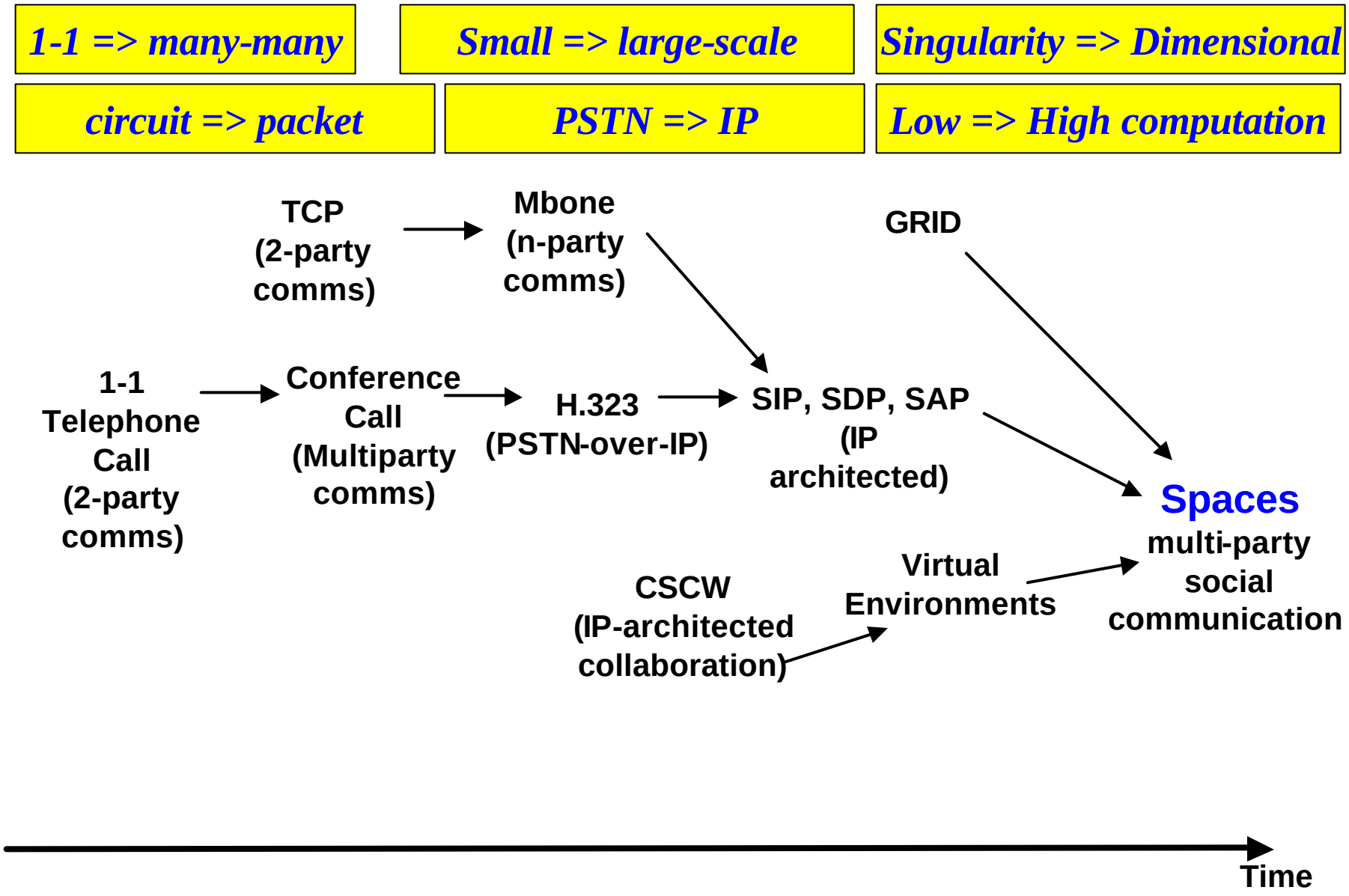
# Architecture



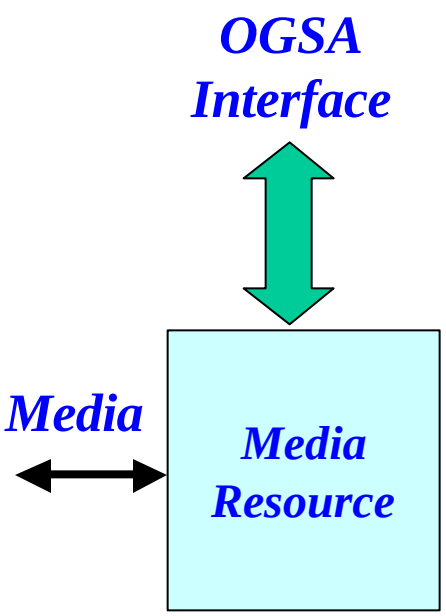
# Spaces

- Similar concerns to sessions
  - Group membership, invite and join protocols, security, characteristics of exchanged media
- No need to reinvent everything
  - Extended SIP,SDP, RTP interface to clients
- Rich Web Services interface to applications
  - Construction of world and policy management

# Evolution of Communications & Session Technologies

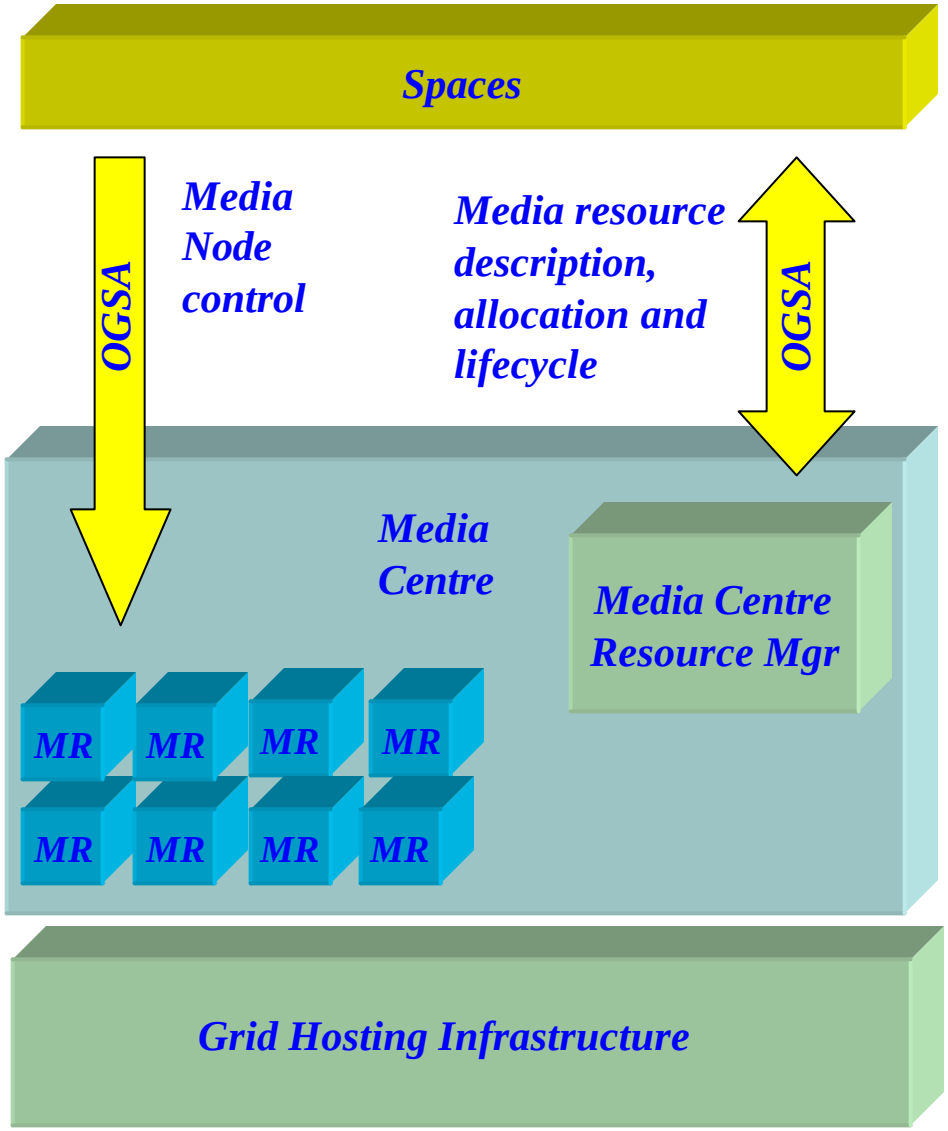


# Media Resources



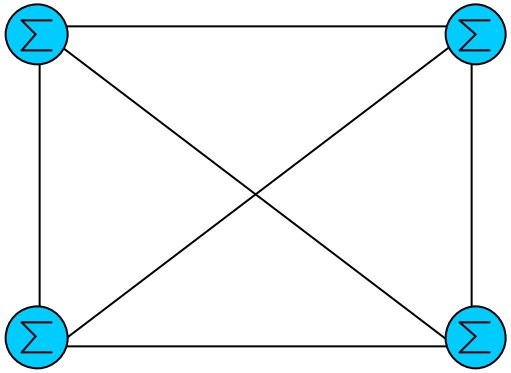

- Building blocks for media processing
- Palette of media functionality
  - Mixing, transcoding, rebroadcasting, record, playback
- Allocated on demand
- Interface exposed as OGSA

# Media Grid Architecture

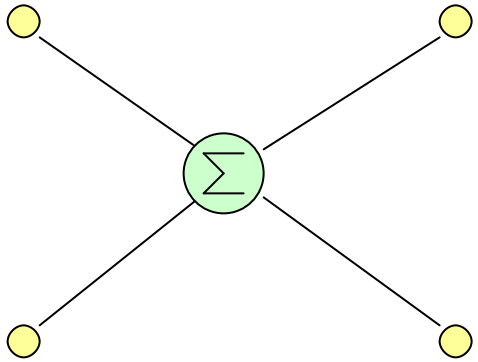



- Media Centre manages pool of Media Resources
  - Provides virtualisation
  - Implementation optimisation
- Sophisticated, fluid audio/media bridge
- OGSA as a control and management technology
- OGSA interface to describe, allocate and control mesh of resources and media interconnection relationships

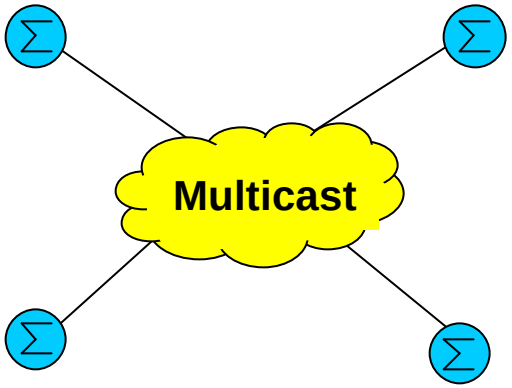
# Mixing architectures for Communication



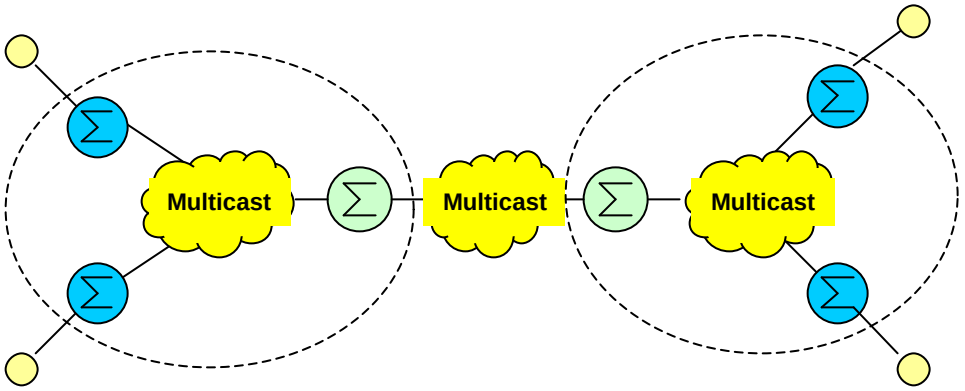
a) Full mesh endpoint mixing



b) Centralised mixing




c) Multicast endpoint mixing




d) Hierarchical mixing

# Why the GRID?

- Ability to manage distributed computing resources on a large scale
  - Service lifecycle management, Security
  - Dynamic allocation to meet demand
- Standard interfaces - OGSA
  - Resource virtualisation
    - OS independence, Soft vs. H/W solutions
  - Uniform Service abstraction for media resources
    - Quickly introduce new services
  - Event notification
  - Intuitive object model
- 21st Century software engineering and deployment technology for Communications
  - Compare to ASN.1 binary encoding and IN protocols

# Summary

***Problem***

Emerging next generation communication applications are not well supported by current communication infrastructure

***Drivers***

Trend to large-scale sophisticated Virtual Meeting Places

Demand for computation, bandwidth and storage

***Opportunity***

Use GRID technology to support large-scale multi-party communication and real-time media processing

***Challenge***

Description, deployment, control, and management of mesh of interconnected media resources to form Media Grid